In-Situ TEM studies of thin film oxide heterostructures

Scientific Achievement

Lorentz TEM data are being used to provide a basis for the development of further analysis techniques based on our advances using the Transport of Intensity equation.

The design and construction of the novel nano-biasing holder are well in hand and will enable us to make local transport measurements across thin oxide layers for direct correlation with microstructure and compositional inhomogeneities.

We have considerable experience in imaging of magnetic domains in-situ in the TEM and this is now being applied to an extended range of materials. Our results in this field so far have led to a better understanding the exchange-bias process in polycrystalline thin films, and of the effect of shape, size and composition on the magnetization reversal in magnetic elements, dots and pillars.

Significance

Critical to an understanding of the novel physical phenomena displayed by these nanoscale systems is the role that their domain structure, magnetisation or polarisation reversal mechanisms, and transport behavior play. Thin film oxide heterostructures exhibit strong nanoscale confinement and exchange effects, which are exciting from a fundamental scientific aspect and are also important technologically. In nanoscale materials it is essential to be able to image the *local* domain structure and to measure the magnitude and direction of local fields. In addition, it is essential to correlate this information with microstructure and microchemistry, on which the electro-magnetic properties are very strongly dependent. It will also be important to carry out such studies over a range of temperatures.

Our in-situ TEM experiments will address these issues for a range of materials systems, by pushing the frontiers of existing techniques and developing new approaches so that we can advance this scientific field beyond what is currently possible.

Our long-term vision is to visualize microstructure, composition, electric and magnetic fields at as high a spatial resolution as possible, using aberration-corrected TEM.

Performers

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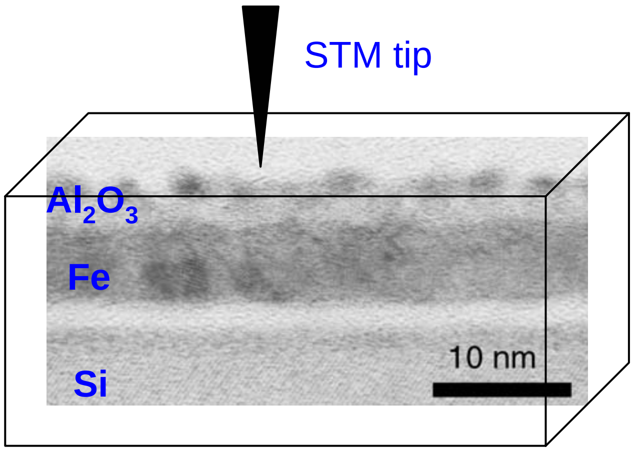
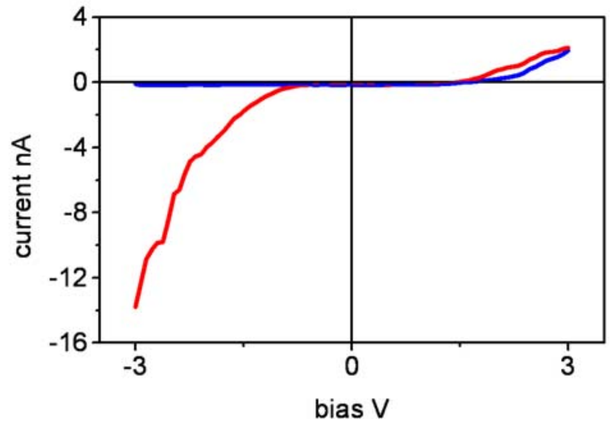
TEM is ideally suited to high spatial resolution imaging of domain dynamics and local tunneling behavior in thin film oxide heterostructures



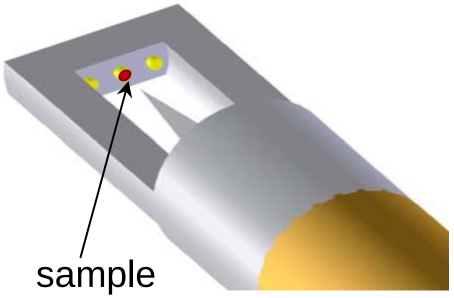


A similar experiment: I-V curves across a 1.4 nm thick Al_2O_3 barrier on a 5 nm Fe electrode show different tunnelling properties on and off Au nanocrystals in the Al_2O_3

Collaboration between Univ. of Oxford (AKPL and J-P Barnes) and MPI, Halle (W. Wulfhekel)

Direct correlation with microstructure will lead to enhanced understanding of their nanoscale properties

Of particular interest will be:
•Interaction of domain walls with interfaces and boundaries
•Effect of local inhomogeneities on transport properties



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